

STEREO MOC Status Report  
Time Period: 2017:275 - 2017:281

STEREO Ahead (STA) Status:

1. The following Ground System anomalies/events occurred during this reporting period:
  - On day 276, during the DSS-34 support, turbo decoder lock was lost briefly at 0722z. This anomaly resulted in the loss of 2 frames of SSR data.
2. The following spacecraft/instrument events occurred during this week. The Ahead observatory operated nominally during this week.
  - The average daily science data return for Ahead was 5.4 Gbits during this week.

STEREO Behind (STB) Status:

1. Detailed status of the recovery activities this week to restore operations is listed below.
  - On day 275, during a 3 hour 1 kHz battery recovery support with DSS-14, 225 commands were transmitted for battery state of charge recovery. Due to the duration of the support, only 25 of the 36 frequency segments were commanded.
  - On day 276, during a 4 hour 1 kHz carrier recovery support with DSS-14, 440 commands were sent for transmitter carrier recovery. No carrier was detected by either the DSN station or the radio science receiver team. Due to the duration of the support and the increased commands for each step, only 22 of the 36 frequency segments were commanded. Three commands must be received sequentially to power on the transmitter.
  - On day 277, during a 3 hour 4 kHz battery recovery search pattern support with DSS-14, the receipt of monitor data was delayed 139 minutes due a server issue at the DSN. The issue was resolved at 1459z and 255 commands were transmitted during the support for battery state of charge

recovery. As monitor data is required for command timing after each sweep, commands were sent manually for 9 of the 16 search pattern points. See DR #N110791 for more information.

- On day 278, during a 3 hour 4 kHz carrier recovery search pattern support with DSS-14, 320 commands were transmitted during the support for carrier recovery. No carrier was detected by either the DSN station or the radio science receiver team. Three commands must be received sequentially to power on the transmitter.
  - On day 279, during a 3 hour 4 kHz carrier recovery support with DSS-14, 320 commands were transmitted during the support. At 1425z, moved the antenna to 200% uplink optimized (0.04 degrees). No carrier was detected by either the DSN station or the radio science receiver team after attempting to power on the TWTA for 30 minutes. Transitioned to battery recovery operations for the remainder of the support which consists of repeatedly sweeping a 4 kHz uplink range and sending commands for IEM switched power and PDU 1553 interface bus off.
  - On day 280, during a 4 hour 4 kHz carrier recovery support with DSS-14, 420 commands were transmitted during the support. At 1733z and again at 1746z, the DCC2 receiver locked to a carrier signal for 10 seconds at -168 dBm and -193 dBm respectively. The RSR team investigated and no carrier was detected. Transitioned to battery recovery operations for the remainder of the support which consists of repeatedly sweeping a 4 kHz uplink range and sending commands for IEM switched power and PDU 1553 interface bus off.
  - On day 281, during a 4 hour 4 kHz carrier recovery support with DSS-14, 380 commands were transmitted during the support. At 1700z through 1703z, the residual Doppler was very close to the expected value on the DCC1 receiver. The RSR team investigated and no carrier was detected. Transitioned to battery recovery operations for the remainder of the support which consists of repeatedly sweeping a 4 kHz uplink range and sending commands for IEM switched power and PDU 1553 interface bus off.
2. The Behind loss of communication anomaly occurred on October 1, 2014 from simultaneous failures of star tracker and IMU. Post superior solar conjunction, recovery operations resumed

on November 30, 2015. By implementing the NASA Failure Review Board recommendations, the first recovery attempt began with carrier detection by the DSN on August 21<sup>st</sup>, through September 23, 2016. At a spacecraft range of ~2 AU, the observatory was found to be rotating slowly about its principal axis of inertia for which the uncontrolled attitude allowed some solar array input and continuous uplink and downlink communications on the LGA at emergency data rates. Over the next 22 continuous days, significant obstacles to recovery were overcome with a collaborative effort of the JHU/APL engineering team, NASA GSFC, DSN, FDF, SSMO scheduling, and Mission Operations teams. This consisted of:

- Reliably commanding a rotating spacecraft with uncontrolled attitude at a distance of 2 AU
- How to power on the spacecraft that was never designed to be off without collapsing the battery voltage
- Acquiring telemetry at 35 bps from a spacecraft that is rotating with an uncontrolled attitude
- Warming a frozen propulsion subsystem with a degraded battery and limited solar array input with an uncontrolled attitude
- Configuring, loading, and verifying EA, C&DH, and G&C parameters and macros with very limited telemetry
- Conducting an autonomous momentum dump in the blind and transitioning to C&DH standby mode and successfully receiving telemetry on the HGA indicating star tracker lock and decreasing system momentum.

However, system momentum level remained above the threshold for re-establishing attitude control with the reaction wheels. Due to the uncontrolled attitude, communication degraded and the last detection of the carrier was on September 23, 2016.

Behind Observatory Status - From the last telemetry received on September 18, 2016 and the telemetry assessment review held on February 24, 2017, main bus voltage is low, 3 out of 11 battery cells are bypassed, attitude remains uncontrolled, rotating about its principal axis of maximum moment of inertia. While likely all ~42 kg of hydrazine remains and is frozen, both pressure transducers are not functioning. EA mode is enabled and autonomy is disabled. The battery charge rate is C/10. RF is configured for the +Z LGA at emergency data rates and the range of the expected best lock frequency (BLF) is known. Necessary macro sequences have been tested to allow the peak power tracker in C&DH standby mode to protect

the battery. These macro sequences will be loaded to EEPROM when the communications supports longer commands.

Based on G&C geometric analysis and GSFC modeling, daily recovery efforts began on August 21<sup>st</sup>, and will continue through November 5<sup>th</sup>. With significant support of the DSN, three different acquisition sequences are being utilized weekly to re-establish communications with STEREO Behind using a 70m track:

1. 4 kHz Sweep - consists of repeatedly sweeping a 4 kHz uplink frequency range for which the BLF was found during the first recovery attempt. Commands are sent to power on the transmitter for 30 minutes. If no carrier signal is detected, the transmitter is powered off and battery recovery commands are sent consisting power off the IEM switched power and PDU 1553 interface bus. This acquisition sequence is used 3 times each week.
2. Frequency Segmented 1 kHz - To ensure command reception, the original faster frequency segmented acquisition sequence is used 2 days each week. This consists of an 18 kHz frequency range divided into 18, 1 kHz segments, each swept at a 1 kHz rate, stepping down in frequency and then back up again. During each segment, the MOC sends for battery recovery on the first day and on the second day, carrier recovery commands. This was the acquisition sequence that originally detected the Behind downlink in August 2016.
3. 4 kHz Sweep with Search Pattern - The DSN created a diamond shaped search pattern with 7 steps of 0.037 deg, dwelling 10 min & 49 sec/step. There are two diamond patterns of 4 steps to cover the area of the estimated ephemeris error. The starting point is offset 0.02 deg for 100% uplink optimization. Repeating each diamond pattern accounts for the 30 minute RTLT. This search pattern acquisition sequence is used twice weekly during 3 hour supports, sending battery recovery commands at each step during the first day and on the second day, sending carrier recovery commands at each step.